What is Claimed:

1. A system for emitting and detecting one or more terahertz frequency electromagnetic pulses, the system comprising a single transceiver device for both emitting and detecting the pulses.

2. The system of claim 1 wherein the single transceiver device comprises an electro-optic crystal.

3. The system of claim 1 wherein the single transceiver device comprises a photoconductive antenna.

4. The system of claim 1 further comprising:

an optical source and related optics for providing:

(a) a plurality of pump pulses to excite the transceiver to emit a corresponding plurality of terahertz output pulses, and

(b) a plurality of probe pulses timed to illuminate the transceiver simultaneously with a corresponding plurality of reflected terahertz pulses;

a chopper for modulating the terahertz output pulses at a first frequency and having a clock output;

an object which is illuminated by the modulated terahertz output pulses and reflects the plurality of reflected terahertz pulses; and

a lock-in amplifier, having a reference input connected to the chopper clock output and auto-locked to the first frequency, for receiving and reducing noise in a plurality of electrical signals, each signal carrying information proportional to a corresponding reflected terahertz pulse as detected by the transceiver.

5. The system of claim 4 further comprising one or more parabolic mirrors between the transceiver and the object.

6. The system of claim 4 wherein the transceiver is a photoconductive antenna that produces the electrical signals received by the lock-in amplifier, each electrical signal produced when a probe pulse and a reflected terahertz pulse simultaneously illuminate the antenna.

7. The system of claim 6 wherein the system further comprises a data processor for processing the noise-reduced output signal from the lock-in amplifier.

8. The system of claim 7 wherein the data processor is adapted to produce a tomographic image based upon a difference in time between the reflected pulses from different layers of the object.

9. The system of claim 7 wherein the data processor is adapted to produce an image based upon a peak amplitude of each of the reflected pulses.

10. The system of claim 6 wherein the transceiver is an electro-optic crystal that reflects a plurality of modulated probe pulses, each modulated probe pulse created when the probe pulse and reflected terahertz pulse simultaneously illuminate the transceiver and the terahertz pulse modulates the probe pulse, the system further comprising:

a photodetector for detecting the modulated, reflected probe pulses and for generating the plurality of electrical signals received by the lock-in amplifier, the electrical signals carrying information transmitted by the modulated, reflected probe pulses.

11. The system of claim 10 wherein the system further comprises a data processor for processing the noise-reduced output signal from the lock-in amplifier.

12. The system of claim 11 wherein the data processor is adapted to produce a tomographic image based upon a difference in time

between the reflected pulses from different layers of the object.

13. The system of claim 11 wherein the data processor is adapted to produce an image based upon a peak amplitude of each of the reflected pulses.

14. The system of claim 2 wherein the electro-optic crystal is mounted to the end of an optical fiber.

15. The system of claim 14 wherein the optical fiber is a polarization-preserved optical fiber.

16. The system of claim 15 wherein the electro-optical crystal has a volume of less than about 1 mm^3.

17. A method for emitting and detecting a terahertz frequency electromagnetic pulse, the method comprising the step of:

(a) emitting and detecting the terahertz frequency pulses using a single transceiver device.

18. The method of claim 17 further comprising the steps of:

(a1) exciting the transceiver device with a pump pulse to emit a first terahertz frequency output pulse;

(a2) modulating the terahertz frequency output pulse with a chopper;

(a3) illuminating an object with the modulated terahertz frequency output pulse so that the object reflects a reflected terahertz pulse; and

(a4) illuminating the transceiver device with the reflected terahertz pulse simultaneously as a probe pulse illuminates the transceiver device, such that the transceiver device produces a first signal carrying information from the reflected terahertz pulse.

19. The method of claim 18 wherein the transceiver device is an

electro-optic crystal, wherein step (a4) comprises the terahertz pulse modulating the probe pulse in the electro-optic crystal and the electro-optic crystal reflecting the modulated probe pulse from a back surface of the electro-optic crystal, wherein the first signal comprises the reflected, modulated probe pulse, the method further comprising:

(a5) detecting the reflected, modulated probe pulse with a photodetector and converting the information to a second signal; and

(a6) reducing noise in the second signal with a lock-in amplifier to produce a third, noise-reduced signal.

20. The method of claim 19 further comprising:

(a7) processing the third, noise-reduced signal with a data processor.

21. The method of claim 20 wherein the object comprises a plurality of layers, each layer a respective distance from the transceiver, the method comprising generating a plurality of pump pulses, probe pulses, and terahertz pulses such that the object reflects a plurality of reflected terahertz pulses, each reflected pulse having a peak amplitude intensity, the method further comprising:

(a8) using information related to the peak amplitude intensity to generate an image of the object.

22. The method of claim 20 wherein the object comprises a plurality of layers, each layer a respective distance from the transceiver, the method comprising generating a plurality of pump pulses, probe pulses, and terahertz pulses such that the object reflects a plurality of reflected terahertz pulses, each reflected pulse having a peak amplitude timing, the timing corresponding to the distance of the layer that reflected the pulse from the transceiver, the method further comprising:

(a8) using information related to the peak amplitude timing to

generate an image of the object.

23. The method of claim 18 wherein the transceiver device is a photoconductive antenna, wherein step (a4) comprises the terahertz pulse and the probe pulse creating a current in the antenna comprising the first signal, the method further comprising:

(a5) reducing noise in the first signal with a lock-in amplifier to produce a second, noise-reduced signal.

24. The method of claim 23 further comprising:

(a6) processing the second, noise-reduced signal from the lock-in amplifier with a data processor.

25. The method of claim 24 wherein the object comprises a plurality of layers, each layer a respective distance from the transceiver, the method comprising generating a plurality of pump pulses, probe pulses, and terahertz pulses such that the object reflects a plurality of reflected terahertz pulses, each reflected pulse having a peak amplitude intensity, the method further comprising:

(a7) using information related to the peak amplitude intensity to generate an image of the object.

26. The method of claim 24 wherein the object comprises a plurality of layers, each layer a respective distance from the transceiver, the method comprising generating a plurality of pump pulses, probe pulses, and terahertz pulses such that the object reflects a plurality of reflected terahertz pulses, each reflected pulse having a peak amplitude timing, the timing corresponding to the distance of the layer that reflected the pulse from the transceiver, the method further comprising:

(a7) using information related to the peak amplitude timing of the reflected terahertz pulse to generate an image of the object.